Cardiovascular Informatics

eHealth team
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http://www.medinfo.cs.ucy.ac.cy/

Outline

- Motivation and Objectives
- Ultrasound Imaging of the Carotid
  - IMT – Styliani
  - IMC (media texture analysis) – Christos
  - Plaque segmentation – Christos
  - Plaque characterization – Costas & Efthyvoulos
  - Plaque motion analysis – Costas, Andrew, Marios
  - Software system – Efthyvoulos
- Risk modelling
  - Stroke - Efthyvoulos
  - Cardiac - Minas
- Telehealth
  - Home monitoring - Efthyvoulos
  - Emergency video telematics – Andreas & Zinonas
- Ongoing EU projects
- Concluding Remarks
- Summary Statistics
- Collaborators

Motivation - WHO

World Health Organization eHealth Strategy [05, 10]

- the use of Information and Communication Technologies (ICT) for health is one of the most rapidly growing areas in health today. However, limited systematic research has been carried out to inform eHealth policy and practice.

eHealth TOOLS & SERVICES

- Decision Support Systems:
  Automated or semi-automated
- Telehealth
  Provision of health care or professional support.

Motivation – EU
eHealth Action Plan 2012-2020

The overall policy objectives of the initiative are: to continue to **support Member States and healthcare providers** so that they may benefit from **ICT solutions in the best interest of patients**, healthcare systems and society; to help enable an **innovation friendly environment** and to **make best use of innovation in health**. In addition, eHealth Action Plan shall ensure the successful achievement of objectives of the Digital Agenda[4] and European Innovation Partnership on Active and Healthy Ageing. To achieve such overall policy objectives at EU level, the Commission plans to work to:
- Increase awareness of the benefits and opportunities of eHealth, and empower citizens, patients and healthcare professionals
- Address issues currently impeding eHealth interoperability
- Improve legal certainty for eHealth
- Support innovation and research in eHealth and development of a competitive European and global market.

Overall Objective

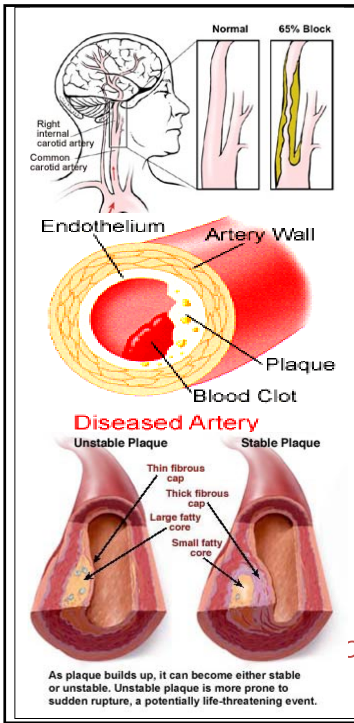
To develop intelligent eHealth systems for the early diagnosis, to enable disease prevention, monitoring, and better treatment.

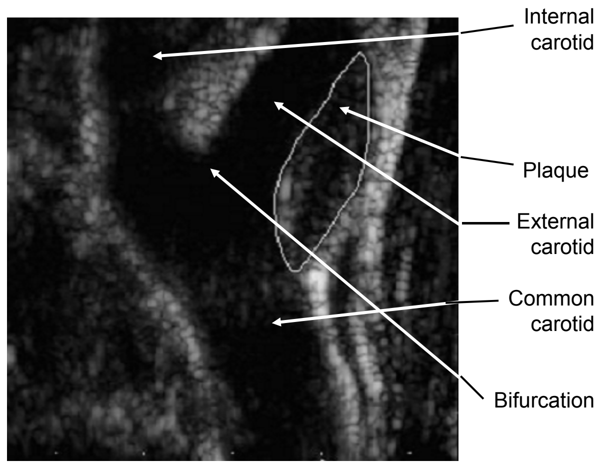
Advantages:

- Standardization (facilitates Telemedicine)
- Sensitivity
- Specificity

Outline

- Ultrasound Imaging of the Carotid





Ultrasound B-mode longitudinal image of the carotid bifurcation with a) plaque in the near wall and b) showing carotid parts.

Center Online , http://www.heartcenteronline.com

Outline

- Ultrasound Imaging of the Carotid
  IMT

Dr Styliani Petroudi

Automated Segmentation of the Common Carotid Artery Intima-Media Complex

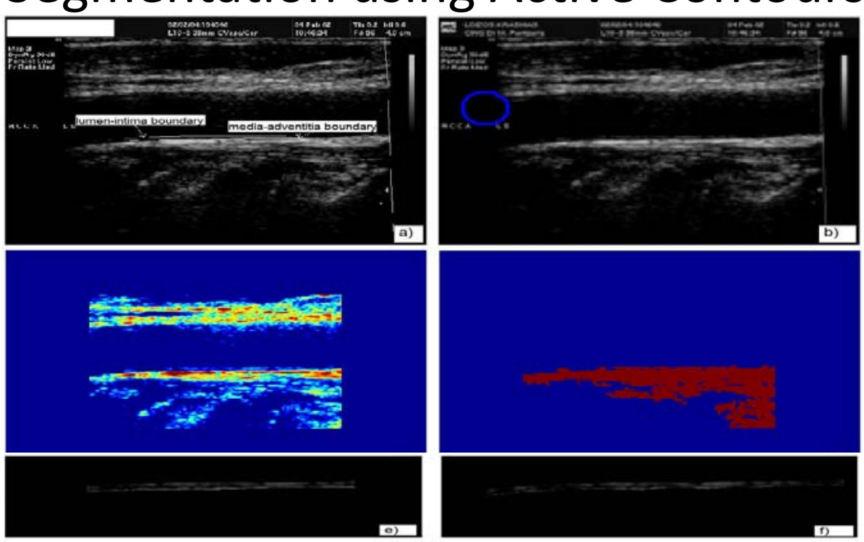
•The Intima Media Thickness (IMT) is an important feature for evaluating the risk for developing CVD.

•The American Society for Echocardiography task force for IMT recommends use of automated border detection programs.

The presented method:

- After despeckling segments the lumen and the near and far wall using level sets to provide the needed information for image normalization and initialization of the parametric active contours for the segmentation of the CCA Intima Media Complex.

Segmentation using Active Contours



a) The US image with the IMC GT outline superimposed, b) Level set initialization, c) Segmentation of the US image in different regions, d) The segmented far wall intima-media adventitia, e) The GT segmented IMC, f) The Automatically Segmented IMC

The IMT Values and Statistics for the Carotid Artery of the Far Wall for a 100 US cases

IMT	Mean in mm	Std in mm	Min in mm	Max in mm
Automatic Segmentation (AS)	0.6054	0.1464	0.3677	1.1746
Ground Truth (GT)	0.6679	0.1350	0.4083	1.1812
Expert 1 (Ex1)	0.6459	0.2554	0.3977	1.2735
Expert 2 (Ex2)	0.6863	0.1644	0.4915	1.089

Evaluation of the absolute IMT Difference Between the Automatic Segmentation versus the Ground Truth and the Individual Expert Annotations for the IMC Segmentation

Absolute IMT differences	Mean in mm	Std in mm	Min in mm	Max in mm
AS vs GT	0.0950	0.0615	0.0007	0.2483
AS vs Ex1	0.1283	0.0756	0.0045	0.2972
AS vs Ex2	0.1013	0.0633	0.0032	0.2603

Outline

- Ultrasound Imaging of the Carotid

  IMC (intima and media complex texture analysis)

Dr Christos Loizou

IMC-Texture Analysis-Literature Review

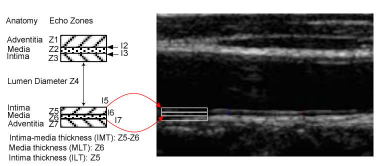
Table 1 – Techniques for carotid artery wall segmentation and IMT measurement. Methodology indicates the basic computer strategy for segmentation. Performance metric indicates the distance metric adopted to assess performance (MAD = mean absolute distance; HD = Hausdorff distance; PDM = Polyline Distance Metric).

Author	Methodology	Year	Performance metric	IMT measurement error	Far wall segmentation		Near wall segmentation		Complete automation	User correction
					LI interface	MA interface	LI interface	MA interface		
Touboul	Edge-detection	1992	MAD	–	–	–	–	–	NO	YES
Liguori	Edge-detection	2001	MAD	–	–	–	–	–	NO	NO
Stein	Edge-detection	2005	MAD	12.0 ± 6.0 µm	–	–	–	–	NO	YES
Faita	Edge-detection	2009	MAD	10.0 ± 38.0 µm	–	–	–	–	NO	YES
Liang	Dynamic programming	2000	MAD	42.0 ± 20.0 µm	–	–	–	–	YES	YES
Gutierrez	Active contours	2002	MAD	90.0 ± 60.0 µm	–	–	–	–	NO	NO
Destrempes	Nakagami modeling	2009	MAD + HD	–	21.0 ± 13.0 µm	0.16 ± 7.0 µm	–	–	NO	NO
Golemati	Hough transform	2007	XTB	–	–	–	–	–	YES	NO
Cheng	Snakes	2002	MSE	–	62.3 ± 60.5 µm	38.4 ± 68.3 µm	–	–	NO	NO
Loizou	Snakes	2007	MAD + HD	50.0 ± 25.0 µm	–	–	–	–	NO	YES
Delsanto	Snakes	2006	MAD	63.0 ± 49.1 µm	59.4 ± 65.0 µm	48.1 ± 50.0 µm	–	–	YES	NO
Molinari	Snakes	2008	MAD	35.0 ± 32.0 µm	56.3 ± 50 µm	50.0 ± 43.8 µm	75.0 ± 56.3 µm	131.3 ± 118.8 µm	YES	NO
Molinari	Snakes	2009	PDM	10.0 ± 10.0 µm	35.0 ± 32.0 µm	37.0 ± 29.0 µm	–	–	YES	NO
Molinari	Integrated approach	2009	MAD	54.0 ± 35.0 µm	91.0 ± 93.0 µm	25.0 ± 55.0 µm	–	–	YES	NO

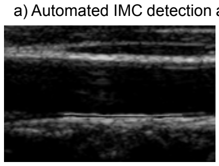
Table 2: Techniques for ML, IL segmentation and Texture Analysis

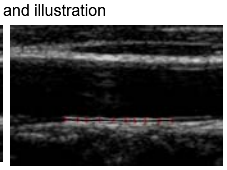
Author	Methodology	Year	Texture Features	Automation
S.M. Ellis	Manual	2000	GSM of ML	No
F. Bartolomucci	Manual	2001	IMC Features for Hypercholesterolemia	No
L. Lind	Manual	2007	IMC GSM correlates with overt CCA plaques	No
C. Loizou	Snakes	2009	61 Texture Features	Yes
C. Loizou	Snakes	2009	IMC, ML, IL between ages <50, 50-60, >60. Texture characteristics from those structures	Yes, Semi automated

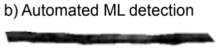
IMC-Texture Analysis- Method

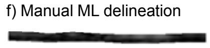


a) Automated IMC detection and illustration


b) Automated ML detection

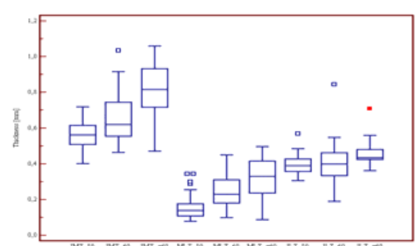

f) Manual ML delineation

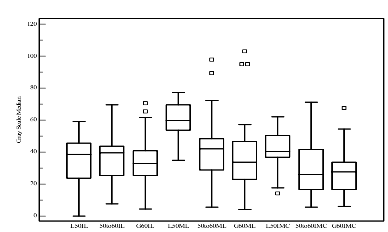

c) IMC Automated=0,73mm


g) IMC (Manual)=0,69mm

d) ML (Automated)=0,36mm

h) ML (Manual)=0,34mm





IMC, ML, IL-Texture Analysis-Discussion

TABLE IV
TEXTURE FEATURES (MEDIAN (IQR)) FOR THE IL, ML, AND IMC USING AUTOMATED SEGMENTATIONS.

	IL	ML	IMC
Mean	35 (19.3)	21 (25)	33 (22)
GSM	35 (18.5)	28 (18)	30 (21.3)
STD	16 (6.6)	14 (7)	16 (5.7)
Contrast	52 (75)	28 (32)	61 (57)
DV	16 (27.8)	81 (56)	32 (32)
Complexity	1704 (3175)	6041 (6762)	4166 (5888)
ASM	0.09 (0.04)	0.002 (0.003)	0.003 (0.002)
Coarseness	20 (14.5)	13 (11)	24 (11.3)
SS-TEL	38 (33)	78 (53)	56 (38)
Entropy	5.7 (1.15)	6 (1.2)	6.6 (0.7)
Roughness	2.46(0.187)	2.2 (0.100)	2.238 (0.079)
Periodicity	0.8 (0.07)	0.9 (0.06)	0.8 (0.2)

IQR: Inter-Quartile-Range, GSM=Gray-Scale Median, STD= Standard Deviation, DV: Difference variance, ASM: Angular second moment, SS-TEL: SS-texture energy laws. SOURCE [11], © CMIG 2009

TABLE V
WILCOXON RANK SUM COMPARISON TESTS PERFORMED ON TEXTURE FEATURES (FIRST COLUMN) EXTRACTED FROM THE IL, ML, AND IMC USING MANUAL (M) AUTOMATED (A) SEGMENTATIONS. IN BOLD FACE, WE HAVE THE TEXTURE FEATURES IDENTIFIED BY THE AUTOMATED SEGMENTATION METHOD THAT ALSO EXHIBIT SIGNIFICANT DIFFERENCES FOR MANUAL SEGMENTATION.

	Manual (M)			Automated (A)		
	IL-ML	IL-IMC	ML-IMC	IL-ML	IL-IMC	ML-IMC
Mean	S (0.01)	NS (0.5)	S (0.001)	**S (0.02)**	NS (0.81)	**S (0.004)**
GSM	NS (0.39)	NS (0.62)	S (0.001)	NS (0.3)	NS (0.45)	**S (0.04)**
Stand. Dev	S (0.01)	S (0.001)	S (0.001)	**S (0.001)**	NS (0.1)	**S (0.001)**
Contrast	S (0.001)	S (0.001)	S (0.001)	**S (0.001)**	NS (0.23)	**S (0.001)**
Diff. Var.	S (0.001)	S (0.001)	S (0.01)	**S (0.001)**	**S (0.007)**	NS (0.09)
Complexity	S (0.001)	S (0.001)	S (0.04)	**S (0.001)**	**S (0.001)**	NS (0.09)
ASM	NS (0.3)	S (0.001)	NS (0.13)	**S (0.004)**	**S (0.001)**	**S (0.001)**
Coarseness	S (0.001)	S (0.021)	S (0.001)	**S (0.001)**	**S (0.005)**	**S (0.001)**
SS-TEL	S (0.009)	S (0.009)	NS (0.13)	**S (0.001)**	**S (0.02)**	NS (0.18)
Entropy	S (0.017)	S (0.001)	NS (0.85)	**S (0.001)**	**S (0.001)**	**S (0.008)**
Periodicity	S (0.001)	NS (0.92)	S (0.001)	**S (0.001)**	NS (0.07)	**S (0.02)**

IL: Intima layer, ML: Media layer, IMC: intima-media complex. The p value is shown in parentheses (S=significantly different at $p<0.05$, NS=Non significantly different at $p>=0.05$). SOURCE [11], © CMIG 2009

IMC, ML, IL-Texture Analysis-Discussion

TABLE VI
TEXTURE CHARACTERISTICS OF IL VERSUS ML BASED ON THE TEXTURE FEATURE VALUES GIVEN IN TABLE I.

Corresponding Features From Table I	IL	ML
Mean, GSM	Brighter	Darker
Contrast, ASM	Higher contrast	Less contrast
Complexity, Entropy	Low Complexity	High Complexity
Coarseness	More coarse, i.e. large areas with small gray tone variations	Less coarse, i.e. less local uniformity in intensity
Roughness	Slightly rougher	Smoother
Periodicity	Less periodical, more heterogeneous	More periodical, more homogeneous

Source [11], © CMIG 2009

Outline

- Ultrasound Imaging of the Carotid
  Plaque Segmentation

Dr Christos Loizou

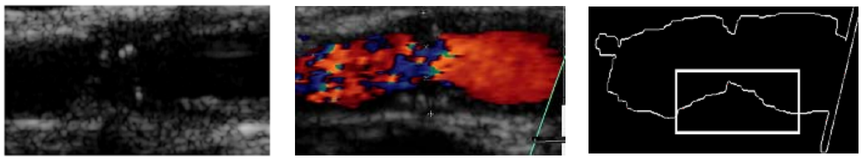
Plaque Segmentation-Literature Review

TABLE I
AN OVERVIEW OF ATHEROSCLEROTIC CAROTID PLAQUE SEGMENTATION TECHNIQUES

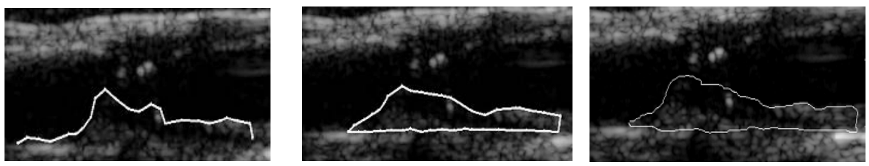
Study	Segmentation Method	2D/3D	AIC	N
	Ultrasound Imaging			
Zahalka et al. [5]	Deformable models	3D	No	69
Hamou et al. [6]	Canny edge detection	2D	No	-
Abdel-Dayen et al. [7]	Morphological based	2D	No	-
Mao et al. [8]	Discrete dynamic contour	2D	No	7
Abolmaesumi et al. [9]	Kalman filtering	2D	No	1
Gill et al. [11]	Balloon	3D	No	2
Delsanto et al. [12]	Deformable parametric model	2D	No	45
Loizou et al. [13]	Snakes	2D	Yes	80
Guerrero et al. [14]	Star kalman algorithm	2D	No	-
S. Golemati et al. [15]	Hough transforms	2D	No	56
Slabaugh et al. [16]	Region based active contour	2D	No	-
	IVUS Imaging			
Zhang [17]	Optimal graph searching	2D	No	20
Cardinal [18]	Fast marching method	2D	No	200
Brusseau [19]	Statistical approach	2D	Yes	15
Olszewski [20]	Knowledge based	3D	No	21
	Magnetic Resonance Imaging (MRI)			
Xu [21]	Mean shift	2D	Yes	22
Adams [22]	Snakes, GVF	2D	No	20
Yang [23]	Dynamic programming	2D	Yes	62

AIC: Automatic initial contour, N: Number of cases investigated.

Plaque Segmentation-Method



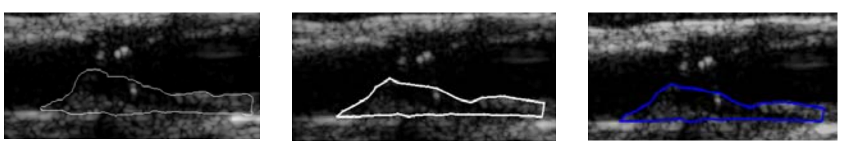
a) Original Image. b) Blood Flow Image. c) Initial Blood flow edge contour.



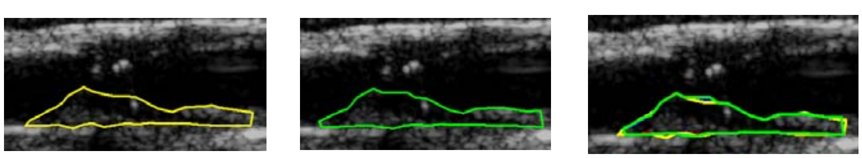
d) Sampled initial snake contour. e) Snakes Segmentation. f) Manual Segmentation.

a) Original ultrasound image of a carotid artery with plaque, b) blood flow image, c) initial blood flow edge contour with expert selected area for the initial contour, d) sampled initial snake contour, e) Snakes segmentation of plaque, and f) manual segmentation of plaque.

Plaque Segmentation-Results



a) Manual delineation. b) Williams&Shah. c) Balloon



d) Lai&Chin. e) GVF. f) All Segmentation methods

a) Original ultrasound image of a carotid artery with plaque, b) blood flow image, c) initial blood flow edge contour with expert selected area for the initial contour, d) sampled initial snake contour, e) manual segmentation of plaque, and f) Snakes segmentation of plaque.

Plaque Segmentation-Discussion

TABLE II
ROC ANALYSIS BASED ON TNF, TPF, FNF, FPF, KI, OVERLAP INDEX, SP, P, AND F=1-E, FOR THE FOUR DIFFERENT PLAQUE SNAKES SEGMENTATION METHODS ON 80 ULTRASOUND IMAGES OF THE CAROTID ARTERY

Segmentation Method	System Detects	Expert Detects no plaque	Expert Detects plaque	KI	Overlap Index	Sp	P	F=1-E
Williams & Shah	No plaque Plaque	TNF=77.59% FPF=6.50%	FNF=19.64% TPF=81.76%	78.86 %	67.60 %	0.935	0.926	0.862
Balloon	No plaque Plaque	TNF=77.12% **FPF=5.40%**	**FNF=13.90%** TPF=80.35%	77.87 %	67.79 %	**0.946**	0.927	**0.888**
Lai & Chin	No plaque Plaque	**TNF=80.89%** FPF=5.86%	FNF=15.59% **TPF=82.70%**	**80.66 %**	**69.30 %**	0.942	**0.934**	0.885
GVF	No plaque Plaque	TNF=79.44% FPF=6.30%	FNF=14.90% TPF=79.57%	77.25 %	66.60 %	0.937	0.926	0.883

Bolded values show best performance
Source [13], © IEEE, 2007

Outline

- Ultrasound Imaging of the Carotid
  Plaque characterization

Dr Efthyvoulos Kyriacou

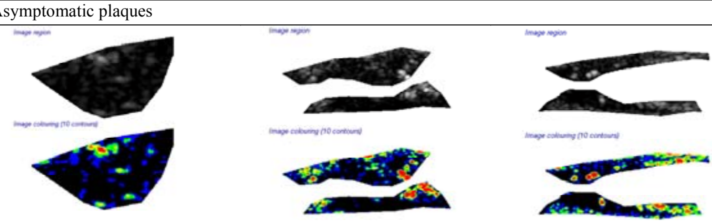
Plaque Characterization

Table I. Ultrasound carotid plaque heterogeneity and clinical implications.

Author	Year	Ultrasound carotid plaque heterogeneity	Clinical implications
Aldoori et al.	1987	Visual classification	Plaque classification
Langsfeld et al.	1989	Predominantly echolucent plaques with a thin "egg shell" cap of echogenicity and echogenic plaques with substantial components of echolucency	Heteroneous plaques more frequently symptomatic. Heterogeneous plaques became symptomatic more frequently during follow-up
ECPSG	1995	Mixed composition	Heterogeneous plaques contained more calcification
Kardoulas et al.	1996	Mixed echo level pattern	Association of plaque heterogeneity with symptoms less consistent in comparison with echolucency
AbuRahma et al.	1998	Plaques composed of a mixture of hyperechoic, isoechoic and hypoechoic plaques. Normal intima-media complex used to define isoechoicity	Heterogeneous plaques more frequently symptomatic
Lal et al.	2002	Ultrasound B-Mode image relation to histology features	Ultrasound and Histology study
ACSRS	2005	Visual classification of high risk plaques based on follow-up of a group of patients	Asymptomatic carotid stenosis follow-up study

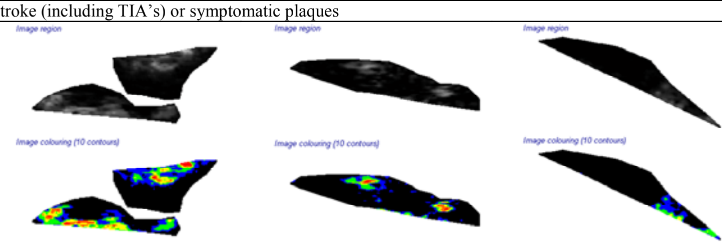
Plaque Examples

Asymptomatic plaques



Median=11	Median=20	Median=24
Area mm^2=53.3	Area mm^2=105.2	Area mm^2=80.6
Discrete White Areas=yes	Discrete White Areas=yes	Discrete White Areas=yes
SGLDM_ASM_mean=3.828	SGLDM_ASM_mean=4.385	SGLDM_ASM_mean=4.563
SGLDM_ENT_mean=4.483	SGLDM_ENT_mean=5.043	SGLDM_ENT_mean=5.227

Stroke (including TIA's) or symptomatic plaques

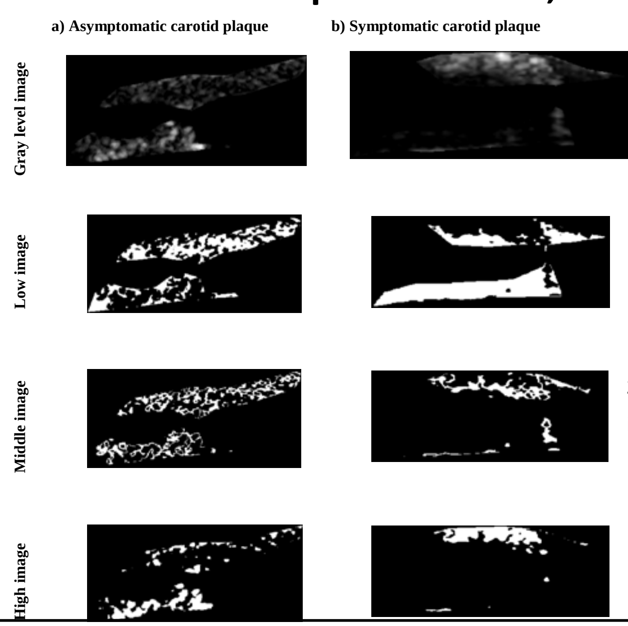


Median=16	Median=4	Median=0
Area mm^2=28	Area mm^2=30.5	Area mm^2=34.7
Discrete White Areas=yes	Discrete White Areas=yes	Discrete White Areas=no
SGLDM_ASM_mean=4.115	SGLDM_ASM_mean=3.245	SGLDM_ASM_mean=2.215
SGLDM_ENT_mean=4.775	SGLDM_ENT_mean=3.838	SGLDM_ENT_mean=2.534

Texture characteristics of symptomatic vs asymptomatic plaques

Symptomatic Plaques	***Asymptomatic Plaques***
more dark	brighter
higher contrast	less contrast
more rough	more smooth
more heterogeneous	more homogeneous
less periodical	more periodical
less coarse, i.e. less local uniformity in intensity	more coarse, i.e. large areas with small gray tone variations

Recent work: Morphological Analysis based on 3 level decomposition- Low, Med, High



I(i,j)<25

blood, thrombus, lipid or haemorrhage

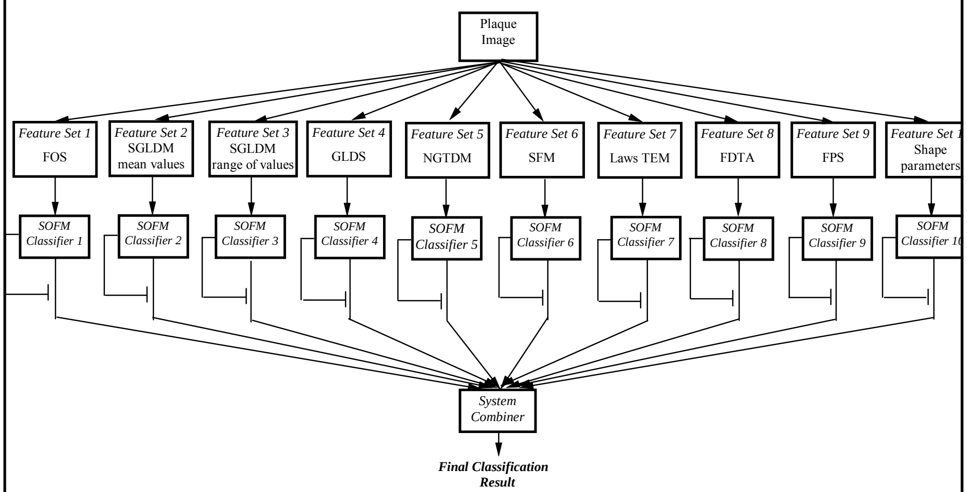
25<=I(i,j)<=50

intermmediate regions

I(i,j)>50

collagen and calcified components

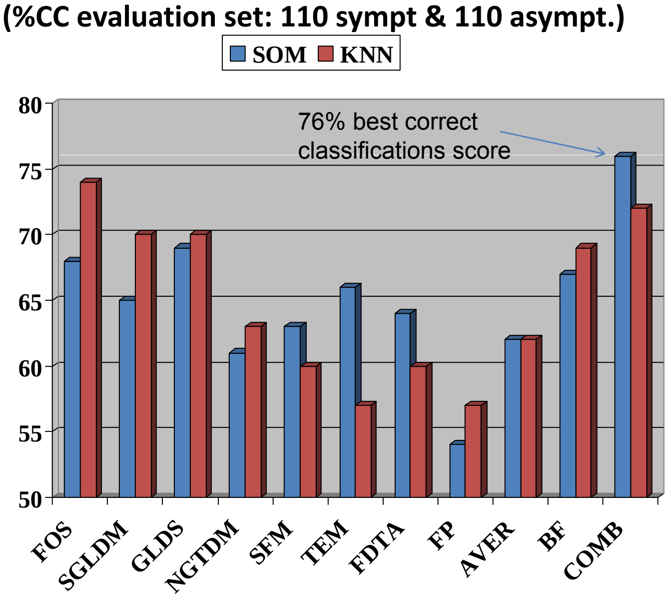
Multi-Feature Multi Classifier Plaque Classification System



[Christodoulou, Pattichis, et. al., IEEE TMI, 2003]

Carotid plaque classification system

(%CC evaluation set: 110 sympt & 110 asympt.)



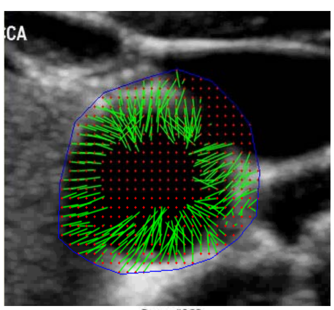
[Christodoulou, Pattichis, et. al., IEEE TMI, 2003]

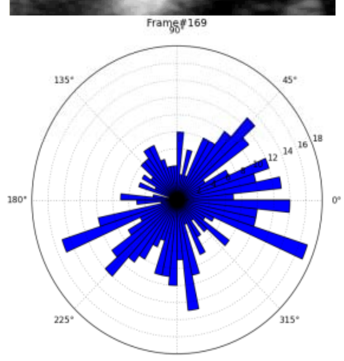
Outline

- Ultrasound Imaging of the Carotid
  Plaque Motion Analysis

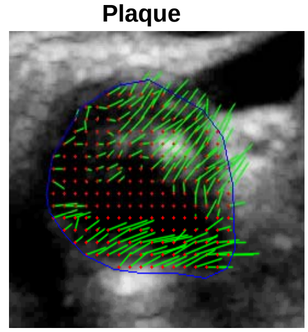
Prof. Constantinos Pattichis
Prof. Andrew Nicolaides
Prof. Marios Pattichis

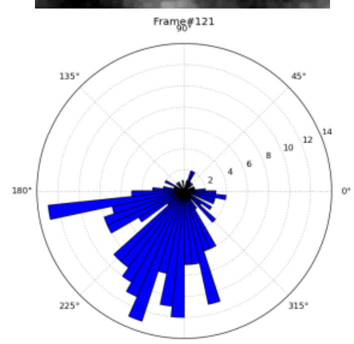
Normal common carotid



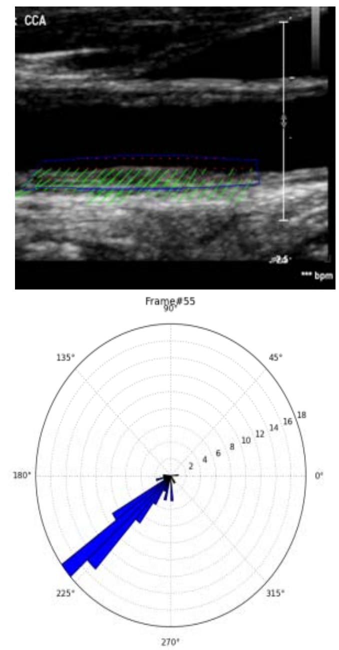


Plaque

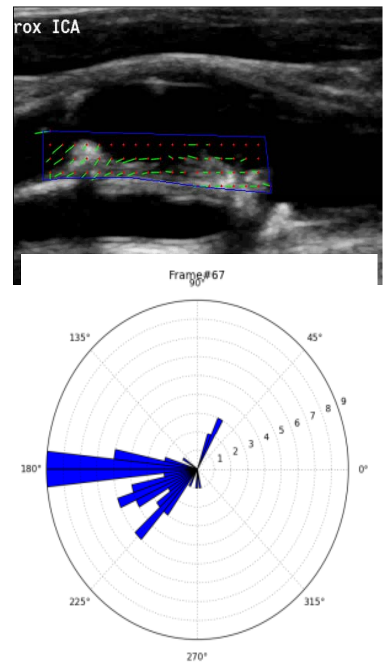




Stable Plaque



Ulcerated Plaque



Outline

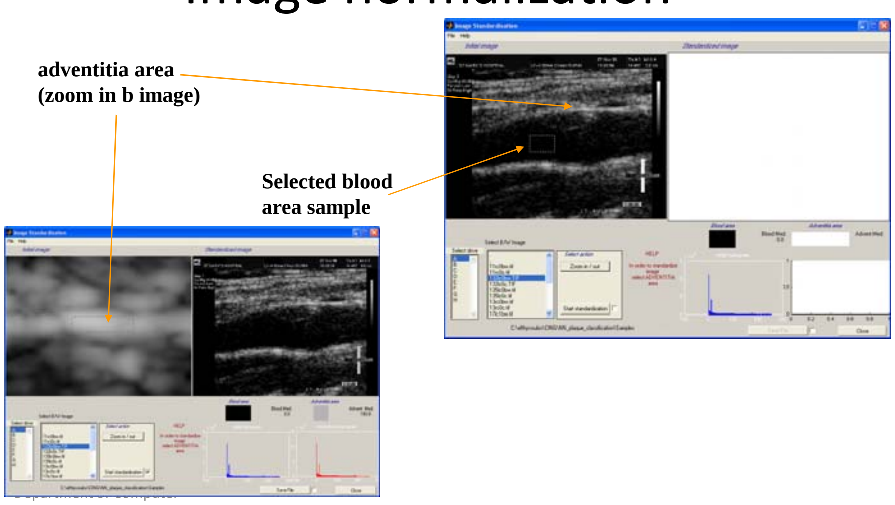
- Ultrasound Imaging of the Carotid
  Software System

Dr Efthyvoulos Kyriacou

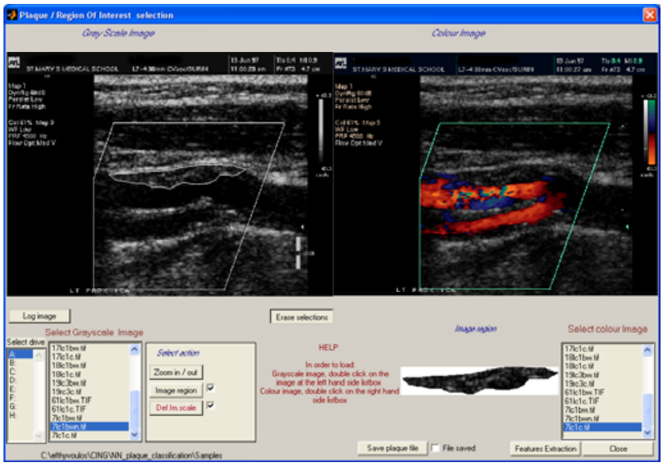
Software System

- Image Normalisation
- Plaque Measurements (IMT, Plaque area, plaque maximum size, stenosis)
- Plaque Segmentation
- Plaque features extraction
- Plaque risk assessment based on the ACSRS results

Software System / Image normalization



Software System
Segmentation of Plaques



Clinical Collaborators using the texture analysis system

- Norway (Tromsoe University)
- UK (Imperial College)
- USA (Columbia University - NY, Jobst Vascular Center, Promedica health system)
- Cyprus (CDER trust)
- Greece (University of Athens, University of Crete)
- Slovenia (University of Ljubljana)
- Poland (Krakow University School of Medicine)
- Spain (Madrid)
- India (Boston Scientific Corporation)

Outline

- Risk Modelling
  - Stroke

Dr Efthyvoulos Kyriacou

Risk Modeling (previous studies)

Author	Year	Short description of study	N	Score
Statistical Analysis Studies				
Geroulakos et al.	1994	Tested the hypothesis that the ultrasonic characteristics of carotid artery plaques were closely related to symptoms. An association was found of echolucent plaques with symptoms and cerebral infractions, which provided further evidence that echolucent plaques are unstable and tend to embolize.	105	
Rakebrandt et al.	2000	This study aimed to construct parametric images of B-scan texture and assess their potential for predicting plaque morphology. Sequential transverse in vitro scans of 10 carotid plaques, excised during endarteectomy, were compared with macrohistology maps of plaque content.	10	
Asvestas et al.	2002	A pilot study with 19 carotid plaques. Indicated a significant difference of the fractal dimension between the symptomatic and asymptomatic groups.	19	
Intelligent Diagnostic Systems				
Christodoulou et al.	2003	A study with 230 plaque images where ten different texture feature sets were extracted. The plaques were classified into symptomatic or asymptomatic using the SOM and KNN classifiers and combining techniques. Furthermore a carotid plaque image retrieval system was developed, based on texture, histogram and correlogram features.	230	73%
Mougiakakou et al.	2007	A study with 108 plaque images where first-order statistical features and Laws' texture energy measures with the neural network back propagation algorithm were used. An overall accuracy of 99.1% in the classification into symptomatic or asymptomatic plaques was reported.	108	99%
Kyriacou et al.	2007	In this work an integrated system for the assessment of the risk of stroke based on clinical risk factors and non-invasive investigations and carotid plaque texture analysis and multilevel binary and gray scale morphological, analysis in the assessment of atherosclerotic carotid plaques.	274	73%

Recent publication

(Confusion matrices SVM prediction model, PNN model based)

Table IV. Confusion matrices for the best SVM prediction model and of the corresponding PNN model based on FS2 Texture - SGLDM features. Sym. represents high risk cases that ended up having a stroke (including TIA's), whereas Asym. represents asymptomatic cases. AF cases were excluded from the study

		Predicted			
Observeda		**SVM**			**PNN**
		Sym.	Asym.	Sym.	Asym.
Sym.	108	89 (82%)	19 (18%)	71 (65%)	37 (35%)
Asym.	991	277 (28%)	714 (72%)	346 (35%)	645 (65%)
Total	1099	366	733	417	682

Positive Predictive Value PPV=24% (SVM), 17% (PNN

Negative Predictive value NPV=97% (SVM), 94.5% (PNN)

Correct Classifications =73% (SVM), 65% (PNN)

Outline

- Risk Modelling
  Cardiac

Dr Minas Karaolis

CODING OF RISK FACTORS

	Risk Factor	Code 1	Code 2	Code 3	Code 4
Risk Factors Before The Event: **non modifiable**					
1	AGE	1: 34-50	2: 51-60	3:61-70	4: 71-85
2	SEX	M: MALE	F:FEMALE		
3	FH	Y: YES	N: NO		
Risk Factors Before The Event: **modifiable**					
4	SMBEF	Y: YES	N: NO		
5	HχHTN	Y: YES	N: NO		
6	HχDM	Y: YES	N: NO		
Risk Factors After The Event: **modifiable**					
1	SMAFT	Y: YES	N: NO		
2	SBP*	L<100	N:100-130	H>=130	
3	DBP *	L<60	N:60-85	H>=85	
4	TC **	N<190	H>=190		
5	HDL**				
	Women	L<50	N:50-60	H>=60	
	Men	L<40	N:40-60	H>=60	
6	LDL**	N<100	H>=100		
7	TG**	N<150	H>=150		
8	GLU**	N <110	H>=110		

L:Low, N:Normal, H:High

* in mmHg ** in mg/dL

CLASSIFICATION RESULTS OF THE THREE SET OF MODELS INVESTIGATED FOR THE FIVE DIFFERENT SPLITTING CRITERIA USING RISK FACTORS BEFORE THE EVENT (B), AFTER THE EVENT (A), AND BEFORE AND AFTER (B+A). THE MEDIAN (ME), (MINIMUM (M) AND MAXIMUM (M)) FOR 20 RUNS ARE GIVEN FOR %CC, %TP, AND %FP, WHEREAS FOR SENSITIVITY AND SPECIFICITY ONLY THE MEDIAN VALUES ARE GIVEN

	%CC			%TP			%FP			Sensitivity			Specificity		
	B	A	B+A	B	A	B+A	B	A	B+A	B	A	B+A	B	A	B+A
	Me(m,M)	Me(m,M)	Me(m,M)	Me(m,M)	Me(m,M)	Me(m,M)	Me(m,M)	Me(m,M)	Me(m,M)	Me	Me	Me	Me	Me	Me
MI															
IG	58(57,64)	61(60,63)	62(61,65)	64(60,76)	68(61,73)	67(53,68)	48(44,55)	45(41,49)	37(25,47)	58	60	63	60	64	63
GI	61(59,63)	61(59,63)	63(61,66)	67(55,71)	59(55,71)	63(57,76)	47(41,59)	36(33,48)	39(25,51)	59	60	62	61	62	64
X2	58(57,60)	61(59,63)	63(62,65)	65(63,73)	63(59,76)	64(59,72)	49(47,53)	39(35,59)	36(35,47)	57	62	64	59	61	64
GR	60(58,61)	59(59,59)	62(61,64)	65(53,72)	59(55,67)	65(53,67)	45(37,53)	41(36,49)	41(38,45)	59	59	62	61	59	62
DM	60(58,62)	59(58,62)	63(61,65)	71(57,67)	61(57,69)	65(57,71)	47(39,54)	43(40,45)	40(27,45)	59	59	65	63	59	64
PCI															
IG	63(61,65)	67(64,75)	67(65,70)	64(53,72)	72(67,78)	58(56,64)	36(31,42)	39(28,50)	22(22,31)	63	65	71	63	69	65
GI	61(61,64)	67(65,68)	67(63,70)	67(50,86)	69(50,75)	67(56,69)	39(28,64)	42(14,50)	31(22,42)	63	64	69	65	64	64
X2	63(60,64)	65(63,72)	65(63,65)	69(56,69)	72(58,78)	72(58,78)	36(33,44)	36(33,42)	42(28,53)	61	64	63	65	65	68
GR	63(61,70)	64(64,65)	65(64,67)	67(56,82)	67(53,83)	72(53,72)	44(31,50)	39(25,56)	39(22,44)	65	63	65	63	65	67
DM	64(63,65)	65(61,71)	65(64,68)	69(64,78)	72(67,78)	69(64,75)	42(33,47)	42(36,56)	39(33,47)	63	62	64	66	67	67
CABG															
IG	69(67,73)	66(63,69)	70(70,71)	70(63,77)	74(65,79)	65(63,65)	35(23,40)	42(33,47)	23(11,26)	67	67	73	70	68	68
GI	69(69,71)	63(61,65)	69(67,71)	67(58,74)	67(56,72)	74(72,74)	28(21,35)	42(30,42)	37(33,40)	70	63	67	68	64	70
X2	69(67,73)	63(61,65)	69(67,72)	72(63,81)	72(63,79)	74(72,77)	33(21,44)	47(42,58)	37(30,42)	67	61	67	69	66	71
GR	69(66,71)	63(61,66)	69(69,75)	67(65,74)	70(61,74)	74(65,77)	35(26,37)	44(28,49)	30(26,40)	67	62	69	68	65	71
DM	71(70,72)	61(59,67)	69(69,71)	67(63,72)	77(58,81)	70(58,74)	28(19,30)	49(40,58)	33(21,35)	73	59	70	71	67	70

THE THREE MOST IMPORTANT RISK FACTORS OF THE THREE SET OF MODELS INVESTIGATED GIVEN IN TABLE III FOR THE FIVE DIFFERENT SPLITTING CRITERIA USING RISK FACTORSBEFORE THE EVENT (B), AFTER THE EVENT (A), AND BEFORE AND AFTER (B+A)

	B			A			B+A		
MI									
IG	AGE	SMBEF	HxHTN	SBP	SMAFT	DBP	AGE	SMAFT	SBP
GI	AGE	HxHTN	SMBEF	SBP	SMAFT	DBP	AGE	SBP	SMBEF
X2	AGE	HxHTN	SMBEF	SMAFT	SBP	DBP	AGE	DBP	HxHTN
GR	AGE	HxHTN	SMBEF	SBP	SMAFT	DBP	SBP	SMAFT	HxHTN
DM	AGE	HxHTN	SMBEF	SBP	DBP	SMAFT	AGE	SBP	SMBEF
PCI									
IG	FH	AGE	HxDM	DBP	LDL	SMAFT	HxDM	DBP	FH
GI	AGE	HxHTN	FH	DBP	LDL	SMAFT	DBP	FH	HxHTN
X2	FH	HxHTN	HxDM	DBP	LDL	SMAFT	DBP	HxHTN	AGE
GR	FH	HxHTN	HxDM	DBP	SMAFT	LDL	HxDM	FH	DBP
DM	FH	HxHTN	HxDM	DBP	LDL	SMAFT	FH	DBP	HxDM
CABG									
IG	AGE	HxHTN	SMBEF	SMAFT	SBP	DBP	AGE	SMBEF	HxDM
GI	AGE	HxDM	SMBEF	SMAFT	SBP	DBP	AGE	SMBEF	HxDM
X2	AGE	SMBEF	HxDM	SMAFT	SBP	DBP	AGE	SMBEF	SMAFT
GR	AGE	HxDM	SMBEF	SMAFT	SBP	DBP	AGE	SMAFT	HxDM
DM	AGE	HxDM	SMBEF	SMAFT	DBP	SBP	AGE	SMAFT	HxDM

SELECTED RULES FROM MODELS

	SEX		AGE				FH		SM		HxHTN		HxDM		CLASS		SUP %	CONF %	EVENT RISK	
	M	F	1	2	3	4	Y	N	Y	N	Y	N	Y	N	Y	N			Y	N
	non Modifiable								Modifiable											
Risk factors before the event (MI)																				
1.1			+												+		19	79	11,8	12,6
1.2				+								+			+		22	76	12,4	11,4
1.3				+						+	+				+		10	67	12,6	12,4
1.4				+					+		+					+	17	68	13,5	13,2
1.5					+			+				+			+		20	63	12,7	12,9
1.6					+			+			+					+	23	59	12,8	13,3
1.7		+				+										+	11	69	12,5	13,2
1.8	+					+		+								+	24	61	12,1	13,4
1.9	+					+	+			+					+		7	64	12,6	12,9
1.10	+					+	+		+							+	10	67	15,0	14,3
Risk factors before the event (PCI)																				
2.1										+		+		+	+		29	71	11,7	12,1
2.2									+			+		+		+	35	64	12,3	12,4
2.3											+			+	+		72	65	12,8	13,0
2.4		+											+		+		13	67	13,1	12,9
2.5	+		+										+		+		2	100	13,1	12,0
2.6	+			+									+		+		10	86	13,1	13,8
2.7	+				+								+		+		21	67	13,1	13,3
2.8	+					+							+		+		20	93	13,3	13,9
Risk factors before the event (CABG)																				
3.1			+													+	20	94	11,5	11,9
3.2				+										+		+	34	79	12,7	12,4
3.3				+									+		+		14	67	13,8	13,2
3.4					+							+		+	+		16	64	13,0	12,5
3.5					+			+			+			+	+		16	57	12,7	12,8
3.6					+		+				+			+		+	19	69	13,3	12,7
3.7					+								+		+		28	71	13,0	13,3
3.8						+									+		53	70	13,4	12,9

Σύγκριση των αποτελεσμάτων της έρευνας της Euroaspire και της δικής μας μελέτης όσον αφορά τους μεταβαλλόμενους παράγοντες επικινδυνότητας μετά από ένα επεισόδιο

14% of subjects smoke after the event (16% in Euroaspire)

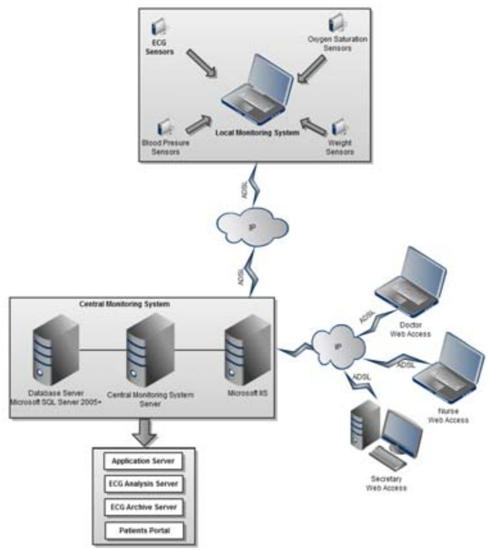
- 22% of subjects had high blood pressure (26% in Euroaspire)
- 34% of subjects had high total cholesterol (31% in Euroaspire)
- 45% of subjects had abnormally high low density lipoprotein (31% in Euroaspire).

Outline

- Telehealth
  Home Monitoring

Dr Efthyvoulos Kyriacou

Home Monitoring



Home Monitoring

- Basic System operations and functions
  - Doctor registration
  - Patient Registration which can be done by the doctor or the nurse
  - Doctors have the ability to give access to another doctor as contributor or just as a viewer.
  - Before and after patient’s treatment several scores are measured based on predefined questionnaires.
  - Historical information relating to previous diseases, medical background and symptoms are handled.
  - Patient calls and follow-up information are handled by the system.

Home Monitoring

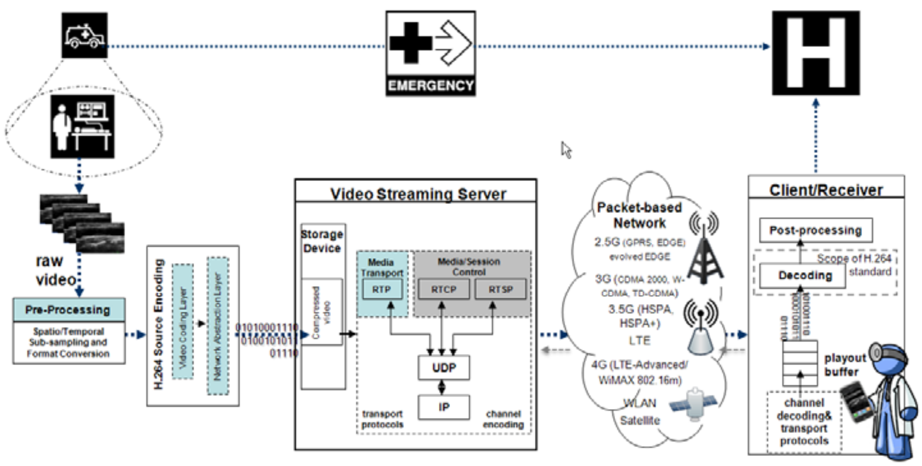
- Several statistics about biosignals and overall graphs of other parameters can be provided to the doctor. These refer to:
  - ECG
  - Weight
  - Blood pressure
  - Oxygen saturation
  - Score statistics
- Automatic analysis of ECG signals for possible arrhythmia detection. The analysis is being done based on an open source arrhythmia detection algorithm provided by E.P Limited [14]
- The doctor has the ability to schedule an archive process for the patient's ECG.

Outline

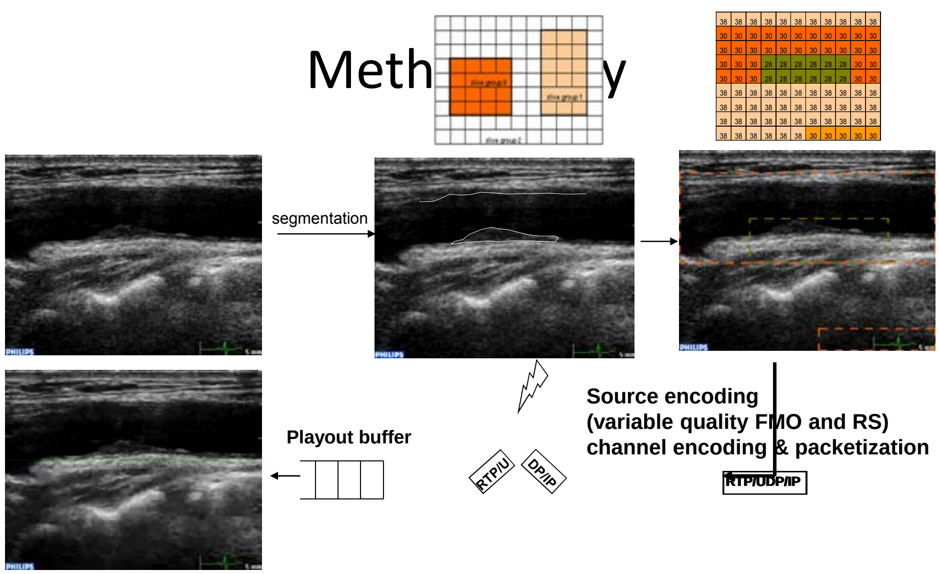
- Telehealth
  Emergency video telematics

Dr Andreas Panayides
& Zinonas Antoniou

Emergency Telemedicine System Architecture



Meth y



Emergency Telemedicine - Main findings

- The proposed unifying framework is based on the following novel concepts:
- *Diagnostically relevant encoding*: quality levels are varied as a function of the diagnostic significance of the video achieving bandwidth demands reductions (between 15% - 60%)
  - Enabling CIF resolution video transmission at 15fps over 3G channels
- *Error-resilient encoding for consistent diagnostic performance*: Exploiting new error resilient methods in H.264/AVC such as FMO and RS qualifying for clinical practice even at 15% PLR (PSNR≥35db)
- *Coarse to fine-parameter optimization for determining minimum bandwidth requirements for diagnostically lossless medical video*
- *Data Set*: Experimentation using a data set of ten ultrasound videos and the biggest considered video cases in the literature
- *Clinical VQA:* based on both subjective and objective ratings, with correlation investigation between MOS and objective measurements

Outline

- Ongoing EU projects

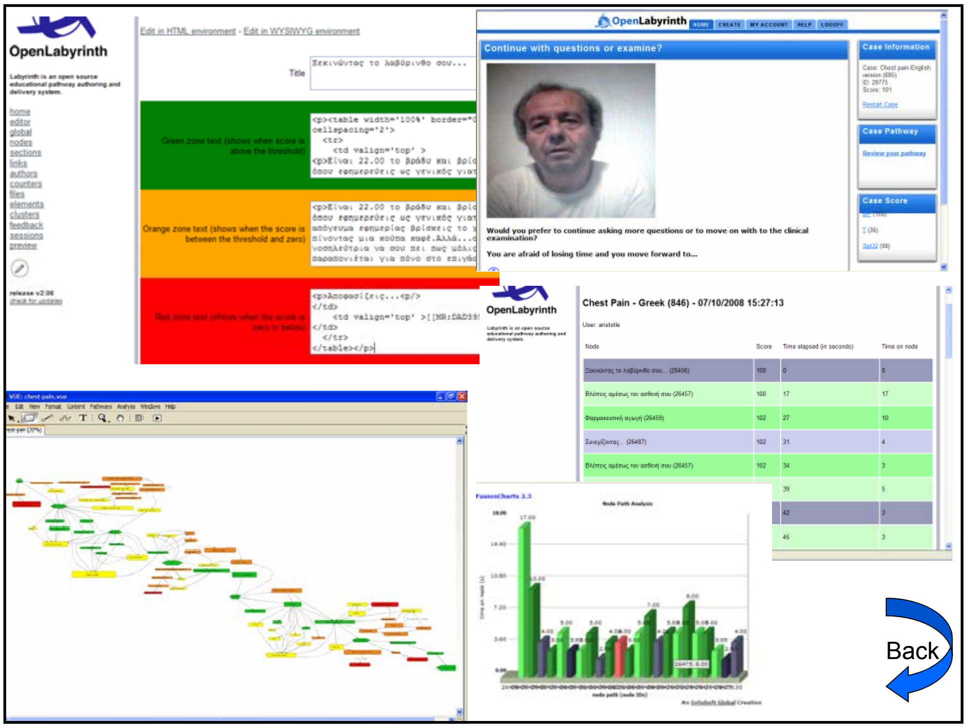
Prof. Constantinos Pattichis

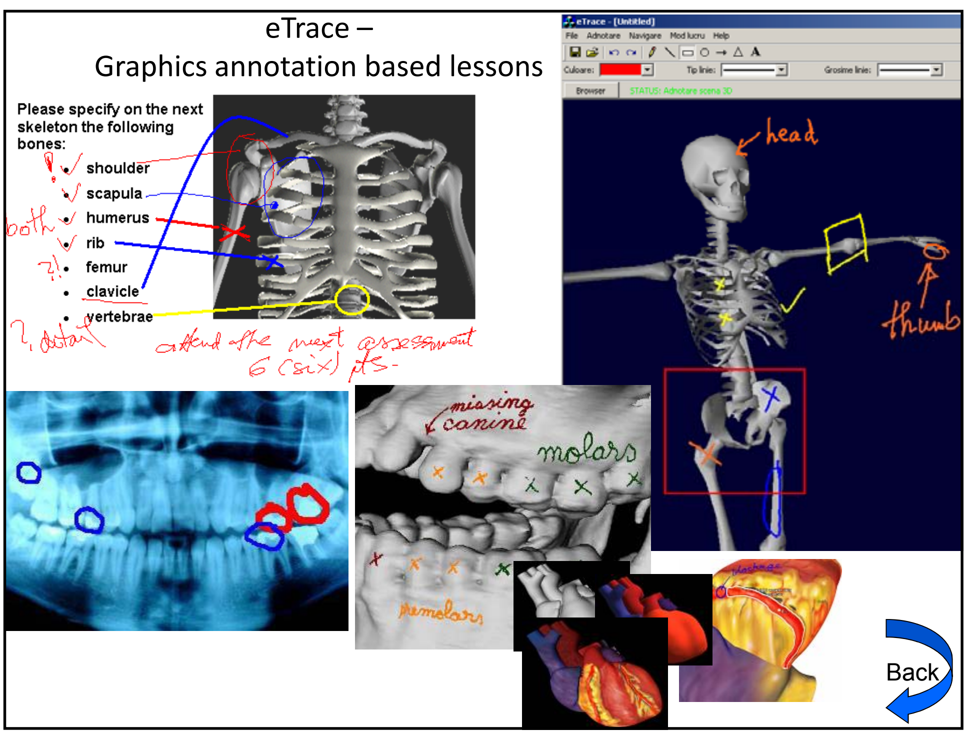
mEducator:
Multi-type Content Repurposing and Sharing in Medical Education

mEducator User-generated Content

- Web2.0 based PBL/CBL
- MEDTING Clinical Cases
- Interactions with Virtual Patients
- Cases in the form of e-traces
- Interactions with serious medical games

55

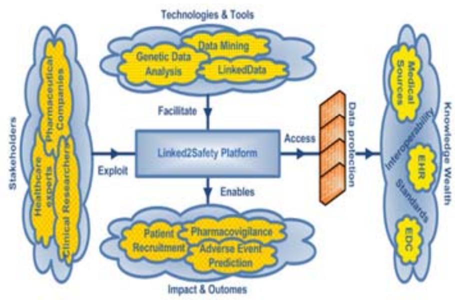

OpenLabyrinth
Continue with questions or examine?
Would you prefer to continue asking more questions or to move on with to the clinical examination?
You are afraid of losing time and you move forward to...
Chest Pain - Greek (846) - 07/10/2008 15:27:13
Green zone text (shows when score is above the threshold)
Orange zone text (shows when the score is between the threshold and zero)
Red zone text (shows when the score is zero or below)
Back


eTrace –
Graphics annotation based lessons
Please specify on the next skeleton the following bones:
shoulder
scapula
humerus
rib
femur
clavicle
vertebrae
head
thumb
missing canine
molars
premolars
Back

Linked2Safety

Linked2Safety www.linked2safety-project.eu	A next generation, secure linked data medical information space space for semantically-interconnecting electronic health records and clinical trials systems advancing patients safety in clinical research

Vision: To advance clinical practice and accelerate medical research, by providing pharmaceutical companies, healthcare professionals and patients with an innovative semantic interoperability framework facilitating the efficient and homogenized access to distributed Electronic Health Records.



Objectives and Expected Results:

- Build the next-generation, semantically-interlinked, secure medical and clinical information space in the enlarged Europe.
- Leverage the reuse of electronic health records in clinical research.
- Support sound decision making towards the effective organization and execution of clinical trials.
- Develop proof-of-concept pilot clinical trials design studies to validate and evaluate the Linked2Safety results.

Concluding Remarks & Long Term Objective

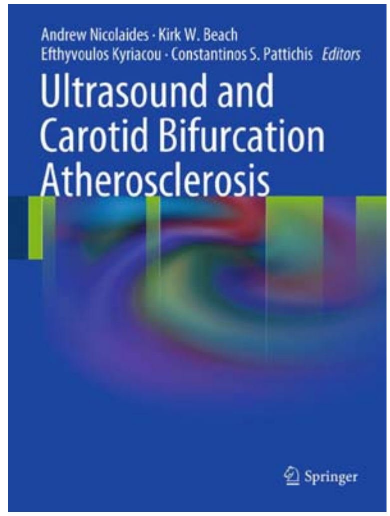
- Integrated medical systems for early diagnosis:
  - Ultrasound – Stroke
  - m-Health for e-Emergency services
- Validated on relatively large numbers of clinical cases
- Applications in clinical practice (expanding)

Enabling better service to the CITIZEN.

Summary numbers

- 67 journal publications
- 160 conference papers
- 22 chapters
- One monograph and one edited volume
- > 1500 citations

- 12 PhDs
- 32 MSc thesis



http://www.medinfo.cs.ucy.ac.cy/

Funding (in excess of 8 million Euro)

- EU
- INTERREG
- Research Promotion Organization, Cyprus
- GSK
- Cadwell labs, USA
- Middle East Cancer Consortium

COLLABORATORS & PROJECT PARTICIPANTS

- Cardiovascular Disease and Education Research Trust, Cyprus
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- The Cyprus Institute of Neurology and Genetics
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- Aretaeion Hospital
  Dr V. Tanos
- Nicosia General Hospital
  Dr C. Antoniades, A. Kouppis, Dr M. Vasiliou, Dr F. Iakovou, Dr P. Kaplanis
- Pafos General Hospital
  Dr P. Constantinides, Dr J. Moutiris, Dr P. Papadopoulos Dr A. Schizas

We are open in new collaborations